

Notice of Allowability

Application No.

10/532,782

Examiner

Jonathan C. Langman

Applicant(s)

KUMAKURA ET AL.

Art Unit

1775

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 12/18/2006.
2. ☒ The allowed claim(s) is/are 5-12.
3. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☒ All b) ☐ Some* c) ☐ None of the:
 1. ☒ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 - 1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
 - (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☒ Interview Summary (PTO-413),
Paper No./Mail Date 12/21/06, 03/14/07.
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____

JENNIFER MCNEIL
SUPERVISORY PATENT EXAMINER

3/14/14

DETAILED ACTION

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Scott Woodbury on March 14, 2007.

The application has been amended as follows:

IN THE CLAIMS:

In claim 5, line 1, delete "vertical"

In claim 5, line 9, delete "vertically"

In claim 6, line 2, delete "vertical"

In claim 6, line 8, delete "vertically"

In claim 7, line 1, delete "vertical"

In claim 7, line 6, delete "vertically"

In claim 8, line 4, delete "vertically"

In claim 9, line 1, delete "vertical"

In claim 9, line 8, delete "vertically"

In claim 10, line 4, delete "vertically"

In claim 11, line 1, delete "vertical"

In claim 11, line 6, delete "vertically"

In claim 12, line 2, delete "vertical"

In claim 12, line 11, delete "vertically"

Allowable Subject Matter

The following is an examiner's statement of reasons for allowance:

The prior art of record does not teach or render obvious the formation of an aluminum oxide on a sapphire substrate, followed by an aluminum oxynitride followed by an aluminum nitride layer.

Hayakawa (U.S. Patent 6,362,515) discloses multiple films, including aluminum oxide, aluminum nitride and aluminum oxynitride films stacked in any combination on a substrate, which may be a sapphire substrate (col. 4, lines 10-17 and col. 6, lines 34-36). However Hayakawa fails to teach or render obvious a specific embodiment where Al_2O_3 and AlON are sequentially deposited on a sapphire substrate. Hayakawa teaches that the dielectric film may be multiple layers of any combination of the materials listed but fails to provide motivation for specifically picking Al_2O_3 and AlON to be formed sequentially onto the substrate.

The prior art of record also does not teach or render obvious the addition of an Al_2O_3 layer on a sapphire substrate before the addition of a nitrated layer.

Fukuyama et al. (U.S. Patent 6,744,076 B2) teach "a single crystalline aluminum nitride film having excellent crystallinity can be formed by converting an alumina component into aluminum oxynitride and aluminum nitride from the surface of the sapphire substrate towards its interior" (Fukuyama et al., col. 2, lines 40-48). A nitride semiconductor is then grown on the laminated aluminum nitride laminated substrate (col. 3, lines 10-12). However, Fukuyama et al. teach the direct nitridation of the sapphire substrate and do not teach or render obvious the implementation of a separate Al_2O_3 layer, as is disclosed by the applicants.

Ramdani et al. (U.S. Patent 5,741,724) teach a method of growing a gallium nitride on a spinel substrate. A first buffer layer of ALON is deposited on the spinel substrate and then second buffer layer includes graded layers of ALON_x to pure AlN by decreasing the oxygen content across graded the layers (Ramdani et al., col. 3, lines 34-47). A high quality GaN layer can then be grown on the buffer layers (col. 3, lines 46). Ramdani et al. do not teach or render obvious the use of a sapphire substrate with an Al_2O_3 layer thereon.

Cho et al., "Effects of N^+ implanted sapphire (0001) substrate on GaN epilayer," teach that "The formation of the AlN layer was obviously due to the penetration and mixing of nitrogen ions on the surface of the sapphire substrate. It was thus important to consider the nucleation behavior of GaN on the modified surface of sapphire that was transformed into amorphous-like AlN phase" (Cho et al., pg. 543, col. 1, lines 6-11). Thus showing that there is only a direct nitridation of the sapphire substrate. The prior

art does not teach or render obvious the addition of a separate layer of Al_2O_3 deposited on the sapphire substrate that is then nitrided, as is disclosed in the instant claims.

Liu et al. "Substrates for Gallium Nitride Epitaxy" teach a sapphire substrate for the epitaxial growth of a GaN substrate (sect. 2., pg. 67). Liu et al. also teach the nitridation of the sapphire substrate before the deposition of ALN, wherein the nitridation converts the sapphire substrate into $\text{AlO}_x\text{N}_{1-x}$ (sect. 2.4.2., pg. 73). Furthermore, Liu et al. teach a surface preparation of the sapphire substrates, wherein the sapphire substrate undergoes an anneal under flowing air or a high temperature anneal in air (Sect. 2.4.1., pg. 72) to form a more uniform surface. However Liu et al. does not show that these anneals in air form a separate layer of Al_2O_3 on the sapphire substrate. Thus showing that there is only a direct nitridation of the sapphire substrate. The prior art does not teach or render obvious the addition of a separate layer of Al_2O_3 deposited on the sapphire substrate that is then nitrided, as is disclosed in the instant claims.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Response to Amendment

The applicant amended claims 5-12 to add the limitation that a nitride semiconductor is vertically grown on the buffer layer or cap layer. The applicant points

to Figures 2 and 6 for support, but it cannot be ascertained from the pictures that the applicant is enabled for vertical growth. There is no reference to vertical growth within the original specification therefore the applicant, in an EXAMINERS AMENDMENT, has removed the limitation of vertical growth.

The 103a rejection by Hayakawa provides for certain multiple layer films deposited on a sapphire substrate, however for reasons discussed above, Hayakawa does not teach or render obvious a specific embodiment that encompasses the structure of the instant claims.

The 103a Rejection by Hayakawa et al. has been withdrawn in view of applicant's remarks to the lack of motivation to sequentially deposit the specific layers.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jonathan C. Langman whose telephone number is 571-272-4811. The examiner can normally be reached on Mon-Fri 9:00 am - 4:30 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer McNeil can be reached on 571-272-1540. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

JCL



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3/14/7